Space Weather Technical Forecast

Issued on Thursday 24 October 2024 at 13:29 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-flares, Slight chance of further X-flares. Chance G1/Minor Geomagnetic Storm intervals Day 3 (26 Oct).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with peak isolated flare X3.3 at 24/0357 UTC from the vicinity of AR3869 in the southeast disc. There are currently around eleven regions on the visible disc with AR3859 having departed over the past 24 hours. The main regions of interest are a collection of potentially complex sunspot regions close to the southeast limb. While currently difficult to assess, these are accompanied by areas of brightness and complex looping evident on SDO AIA-94 and AIA-171 imagery respectively.

A number of weak CMEs were observed leaving the Sun, however these have all been assessed as missing Earth. The C7.8 flare appears to not have produced a CME, although a significant EUV-dimming was observed at the same time across the north disc; this CME has is expected to pass north of Earth. The strong X3.3 flare produced a CME that has been assessed as a likely miss, passing behind Earth. However, Enlil modelling is underway and some Earth-directed component remains possible.

Solar Wind / Geomagnetic Activity: Solar winds showed initial weak enhancement to around 400 km/s, attributed to the belated onset of a fast wind from CH82/-. The subsequent jump in winds around 23/1800 UTC to a peak of 440 km/s may have also been associated with this HSS, however, this is low confidence and may have instead been the result of slight glance from a CME. Solar wind speed, observed by ACE at L1, are currently around 340 km/s having declined steadily since about 23/2100 UTC. The Interplanetary Magnetic Field (IMF) remained mostly weak, with brief Moderate spells, varying between 3-9nT. The north-south component was also weakly variable, fluctuating weakly between -7nT and +7nT, but was predominantly southwards oriented between 24/0000-0540 UTC. Phi angle was predominantly positive (away from the Sun), with brief periods of negative (towards the Sun) earlier on 24 Oct.

Geomagnetic activity was Quiet to Unsettled (Kp1-3), but with an Active interval 24/0600-0900 UTC.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at Background levels. High energy electron flux (greater than 2MeV) observed by GOES16 remained at background, with a diurnal peak at Moderate. The associated 24-hour fluence was well below the Active threshold.

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Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate is expected, with a chance of isolated M-class flares and a slight chance of further X-class flares. Source of strongest flares likely to be the complex group of regions close to the southeast limb. A new or returning region is expected to rotate onto the disc during Days 1-2 (24-25 Oct), otherwise no significant arrivals or departures are expected during the period.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs currently expected. Background solar winds are expected until the arrival of a stream of fast winds from CH84/- Day 3 (26 Oct) or possibly Day 4 (27 Oct), with slightly elevated to elevated winds likely. Winds then easing later Day 4.

Geomagnetic activity is forecast to be Quiet to Unsettled, easing to many Quiet Day 2 (25 Oct). CHActivity is expected to remain largely Quiet to Unsettled (Kp 1-3), easing to many Quiet Day 2 (25 Oct). Any further CH84 sourced enhancement will bring a spell of Unsettled to Active activity (Kp 3-4), with a slight chance of G1/Minor Geomagnetic Storm intervals (Kp 5) Das 3-4. The low confidence influence of any glancing blows from CME arrivals Day 3 sees a rise in probability of G1/Minor Geomagnetic Storming.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is expected to remain at background. High energy electron flux at GOES16 is forecast to remain to persist at mainly background, with the associated 24 hour fluence remaining well below Active.

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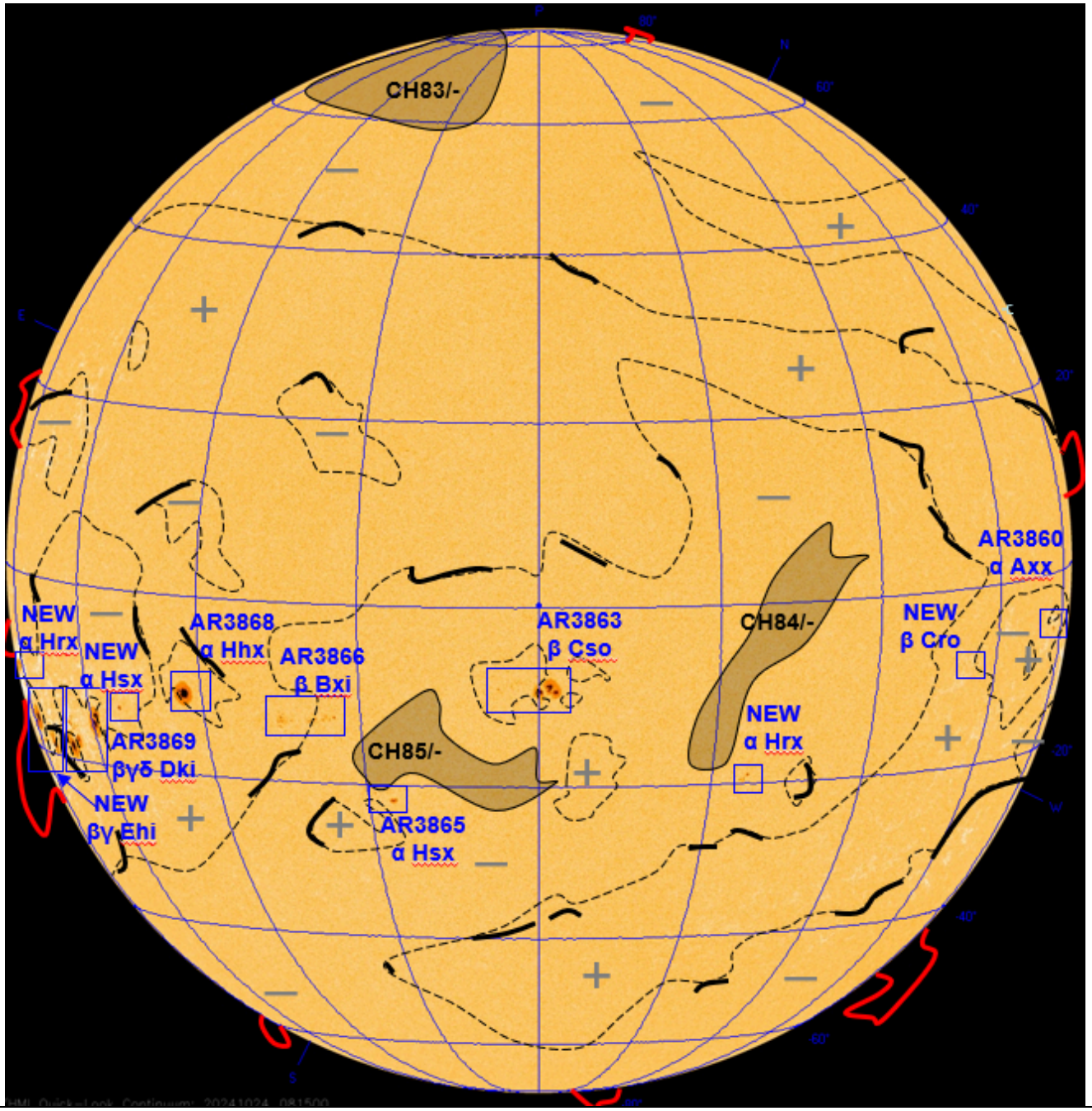
Figure 1: Solar Synoptic Map VT 24/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The are no Earth-directed CMEs. Modelling of the X3.3 CME from 24/0357 UTC is underway, with preliminary assessment supporting a miss.

Solar winds are currently at background levels following the belated connection to the weak CH82+ HSS. Winds are expected to remain at largely background levels until Day 3 (26 Oct) with fast winds from CH84/- perhaps peaking at elevated speeds before waning during 27 Oct. Speeds are most likely to be slightly elevated (450-500km/s) given the less favoured polarity for a strong geomagnetic connection at this of year. Enlil wind speed projections are considered reasonable with SWPM supporting similar values.

A number of weak CMEs from 23 Oct have been modelled to miss Earth, although there remains an element of uncertainty in the nature of the CME observed around 23/1230UTC and the potential for an Earth-directed component and glancing blow on 26 Oct. The main CME of note for the forecast period is from the X3.3 flare at 24/0357 UTC. This CME originated from close to the southeast limb, with the bulk of ejecta expected to pass to the south of Earth. However, there remains the possibility of a glancing blow from shock during 26 Oct which may sweep up the previously mentioned CME. The combined result of these features and the weak HSS may result in some geomagnetic enhancement.

Activity is expected to remain largely Quiet to Unsettled (Kp 1-3), easing to many Quiet Day 2 (25 Oct). The onset of any enhancement from CH84/- during Day 3 (26 Oct) or early Day 4 (27 Oct) may bring a spell of Unsettled to Active (Kp 3-4) geomagnetic activity with a slight chance of G1/Minor Geomagnetic Storm intervals (Kp 5). The low confidence influence of any glancing blows from CME arrivals during 26 Oct, leads to a slight increase in the probabilities for a G1/Minor Geomagnetic storm Day 3.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	5	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: MOSWOC SWPM

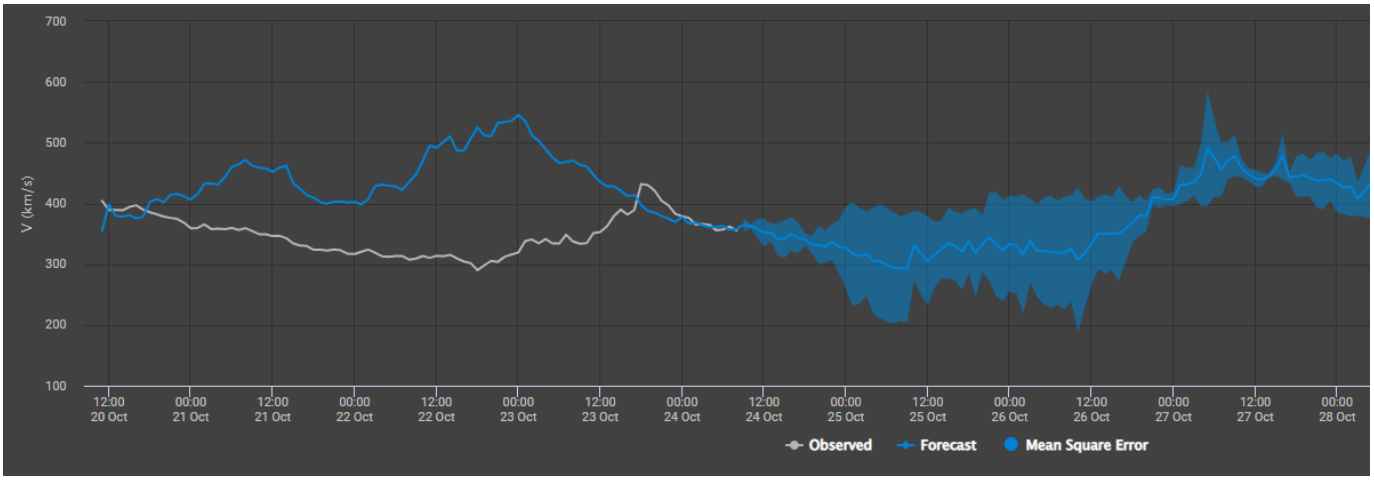

Figure 3: MOSWOC Enlil showing connection to HSS 26-27 Oct

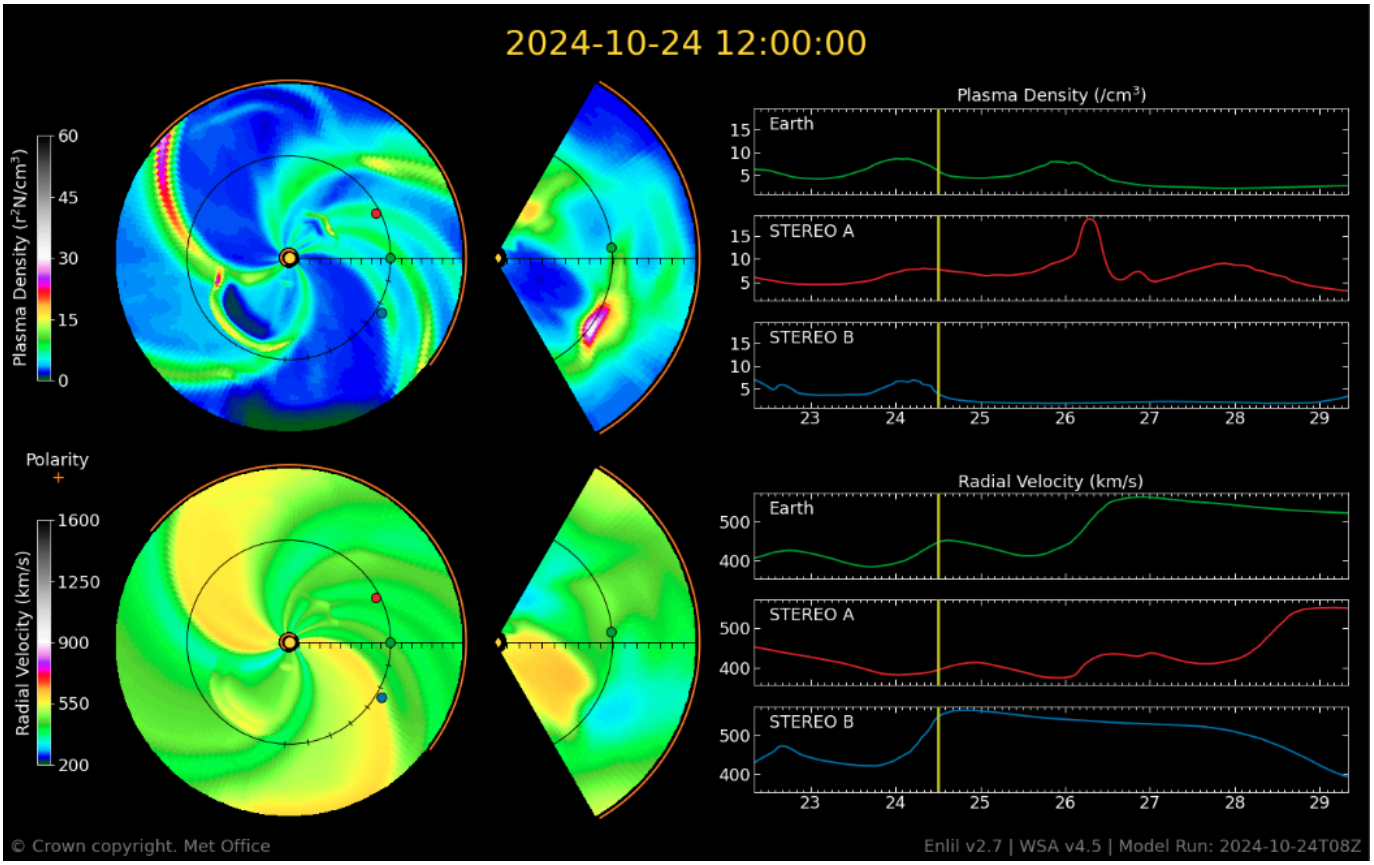

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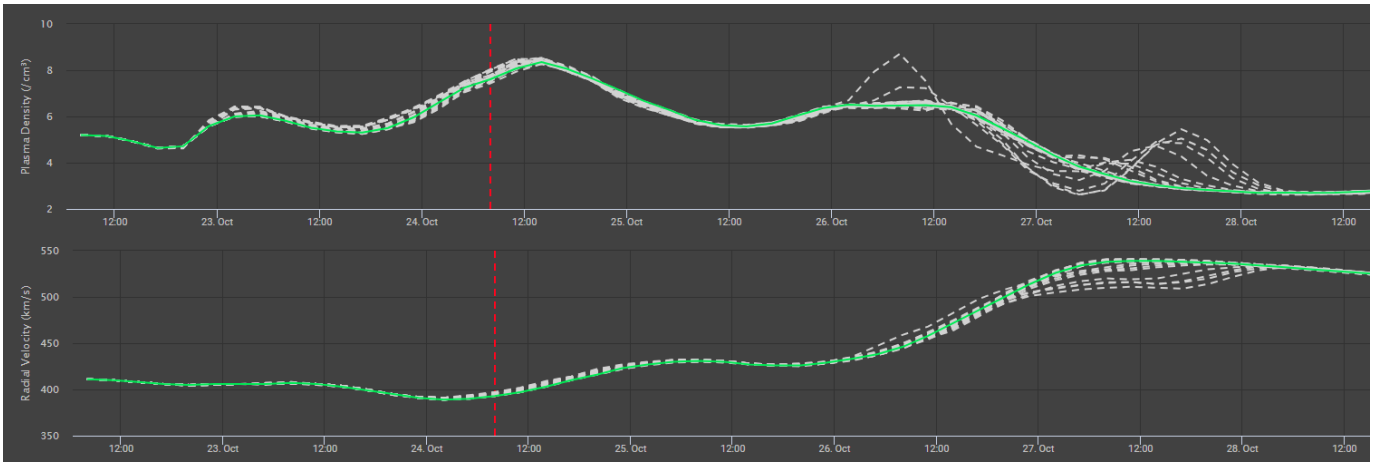
Figure 4: MOSWOC Enlil Ensemble alluding to uncertainty in onset time of HSS 26-27 Oct



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Radio Blackouts - X-Ray Flares

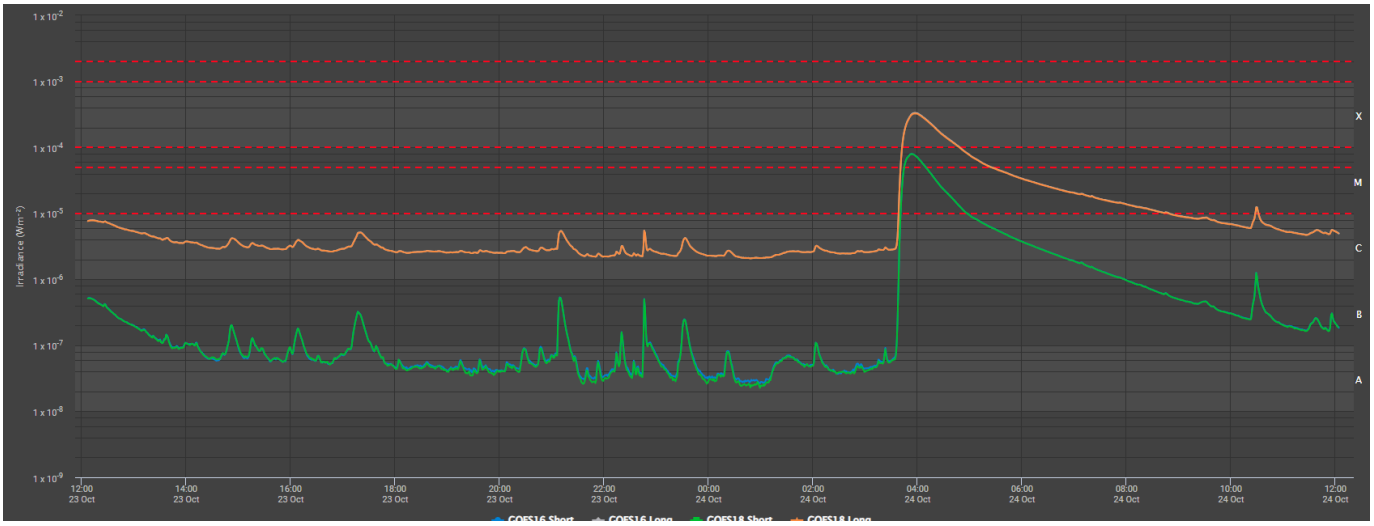
Low to Moderate activity is expected, with isolated M-class flares likely and a slight chance of further X-class flares.

There are currently eleven sunspot regions on the disc. Many of the regions on the disc are small and simple, particularly in the western disc. The main focus of activity is in the southeast disc and close to the eastern limb where several potentially complex regions are located, or are due to rotate onto the disc. This includes AR3869 (Dki/Beta-Gamma-Delta) and an unnumbered region both of which considered to be complex regions, but may be merged into one larger sunspot region following subsequent analysis. The delta configuration is low confidence due to fore-shortening. Given the bright magnetic looping evident on SDO AIA-94, along with the structures visible on other SDO imagery, further complexity is likely to become apparent as the regions rotates further onto the disc. A further new region is also rotating onto the disc just to the north of the aforementioned cluster of sunspot regions.

Despite largely quiet activity, the regions in the southeast and the oncoming region result in the increased potential for M- or X-flares through the period.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	60	60	60	60
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 5: GOES16 and GOES18 X-Ray Irradiance Trace over past 24 hours. Note the X3.3 and slow decline towards C-class.



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Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES-18 is forecast to remain at background, although some slight proton enhancement is possible should further significant flares occur. The current most active regions located near the east limb, and no notable regions currently lie on the west disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	2	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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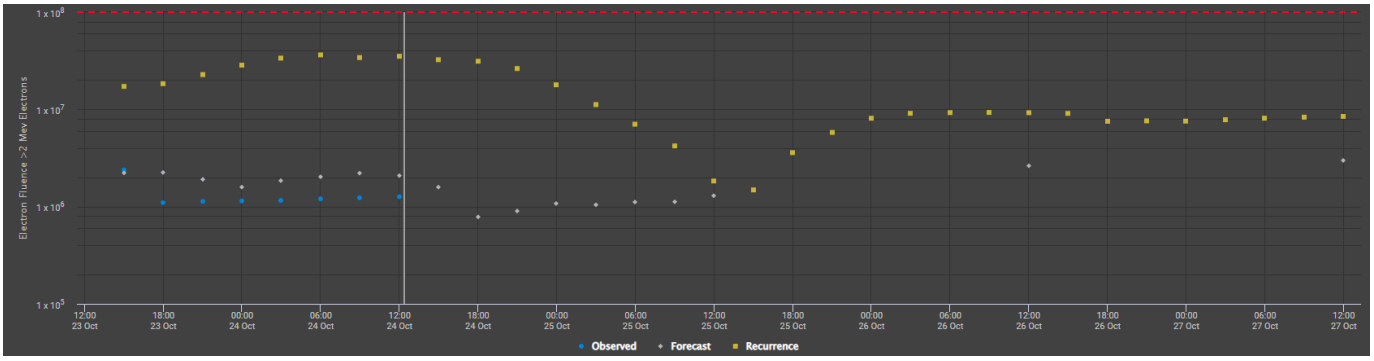
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background, and is expected to persist mainly at this level with no significant enhancements expected.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period, with MOSWOC REFM providing good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM considered to be giving good guidance.



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